Section 3A

Petroleum

Molecular Compounds

A molecular compound is a compound comprised of only non-metal and metalloid elements. These compounds are connected by covalent bonds.

When naming these compounds, we use Greek prefixes to tell how many of each element we have.

Naming Molecular Compounds

When naming these compounds, we use special rules:

1) Name the first element in the compound. If there is more than one of this element, signify this with the appropriate Greek prefix.

2) Follow this with the second element with the appropriate prefix and an -ide ending.

*** The prefix mono- is not needed on the first element if it is single, however, it must be placed on the second element of the compound.***

Numerical Prefixes

mono-	1
di-	2
tri-	3
tetra-	4
penta-	5
hexa-	6
hepta-	7
octa-	8
nona-	9
deca-	10

Polar and Nonpolar Covalent Bonds

There are two kinds of covalent bonds:

Polar Covalent - When atoms with different electronegativities form a covalent bond, the shared electrons are more strongly attracted to the atom that is more electronegative.

Electronegativity difference between 0.5 and 1.9.

Nonpolar Covalent- Electrons are shared relatively evenly.

Electronegativity difference less than 0.5

Bonds and Electronegativity

Another way to determine the types of bonds within a compound is to use an electronegativity chart.

An ionic bond exists if the electronegativity difference between two atoms is greater than 1.9.

There are two types of covalent bonds: polar and nonpolar.

Lewis Dot Diagrams

Valence electrons are electrons in the outermost level of the atom.

To show the number of valence electrons we write the symbol with a dot representing the proper number of valence electrons

Octet Rule

Atoms tend to gain, lose or share electrons in order to acquire a full set of valence electrons.

"Octet" comes from the idea that most atoms want to have eight electrons in its outermost level (shell).

An octet will be either 0 or 8 valence electrons.

Exceptions to this rule are H, He and the transition metals.

Drawing Ionic Compounds

Using the Lewis structures, we can show the ionic bonding of compounds.

In ionic compounds, electron(s) transfer from one element to another, making cations and anions that attract one another.

Ex: Sodium Chloride (NaCl)

Drawing Covalent Compounds

Another way that compounds can form is when the electrons are shared between 2 or more atoms to complete an octet. This results in a molecule with covalent bonds.

A molecule that combines covalently is ammonia NH_3 :

Very often in covalent compounds, there are unshared pairs of electrons which belong exclusively to one of the atoms.

Multiple Bonds

Two atoms may form double or triple covalent bonds in which multiple pairs of shared electrons are used to satisfy the octet rule.

Example: Carbon Dioxide, CO_2

Limitations of Lewis Dot

Lewis Dot structures tell us how the atoms of a compound bond to one another, but they do not tell us the shape of the molecule.

In order to demonstrate the bonding of atoms in molecules, we shall use the ball and stick models.

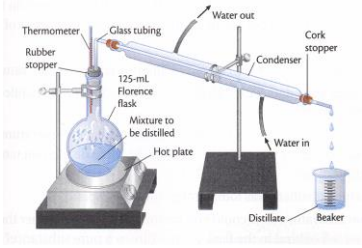
Hydrocarbons

Petroleum is pumped out of the ground as crude oil. The crude oil is then shipped to refineries to be broken down into specific hydrocarbons

Hydrocarbons are compounds that contain carbon and hydrogen elements.

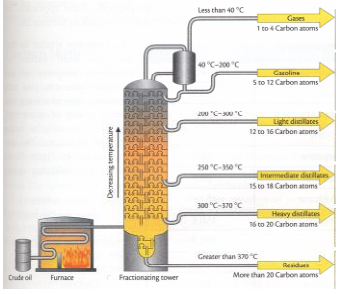
Hydrocarbons are molecular compounds.

Distillation



Fractional Distillation

- The crude oil is heated to 400 ºC, put into the column, and then as the vapor rises, it condenses.
- The higher the gases travels up in the column, the lower its boiling point.

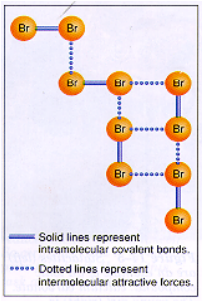


Why the different boiling points?

The forces that hold the molecules together in a liquid or a solid are called intermolecular forces. These are the forces of attraction between neighboring molecules. (inter - outside)

Substances that have no intermolecular forces are gases. Substances in which the intermolecular forces are strong enough to hold the molecules to one another are solids or liquids.

The higher the boiling point, the stronger the intermolecular forces.



Attractive Forces

When we discuss the state of matter, we must discuss the strength of attractions between its particles. What is this relationship between the particles attraction and their KE?

The stronger the attractive forces between a substances particles, the lower the KE.

VSEPR Theory

Atoms and electrons within a molecule will repel one another. Therefore, scientists developed the VSEPR Theory:

In a small molecule, the pairs of valence electrons are arranged as far apart from each other as possible.

This theory does not work for all elements (esp. the transition metals), but is a good basis for understanding

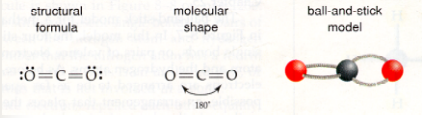
Molecular Geometry

Linear:

All molecules that contain 2 atoms are linear. (Ex. HCl)

Some 3 atom molecules are also linear. (Ex. CO_2)

The bond angle in a linear molecule is 180 degrees.



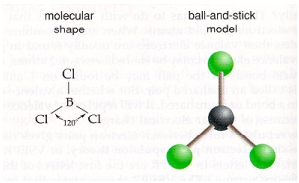
Molecular Geometry

Trigonal Planar:

Trigonal means triangular and planar means flat.

A trigonal planar molecule has a central atom bonded to three other atoms and no unshared pairs of electrons. (Ex. BCl_3)

The bond angle is 120 degrees.



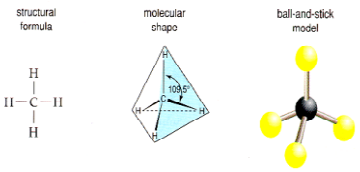
Molecular Geometry

Tetrahedral:

Tetra means 4 and hedral means surface. A tetrahedral has four bonds.

The tetrahedral is 3 dimensional not 2 dimensional. Therefore, the bond angle is not 90 degrees.

Bond angle 109.5



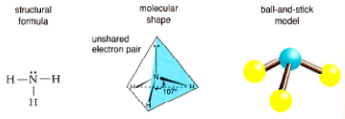
Molecular Geometry

Pyramidal:

Same as tetrahedral, but with one pair of unshared electrons. This electron pair takes the place of one of the bonds of a tetrahedral.

A pyramidal molecule typically has a central atom with three atoms bonded and an unshared pair of electrons.

These unshared electrons also take up a little more room (greater repulsion force) than a bonded atom, so the bond angle is reduced to 107 degrees.



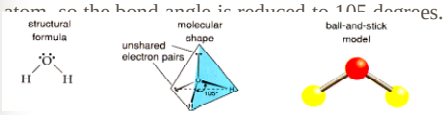
Molecular Geometry

Bent:

Same as tetrahedral, but with two pairs of unshared electrons. These electron pairs take the place of two of the bonds of a tetrahedral.

A bent molecule has a central atom with two atoms attached and 2 unshared pairs of electrons.

These 2 unshared electron pairs take up still a little more room (greater repulsion force) than a bonded atom, so the bond angle is reduced to 105 degrees.



Molecule Polarity & Dipoles

A molecule, just like bonds, can be polar or nonpolar. It depends on the bonds and the shape of the molecule.

A polar molecule has one end with a positive charge and one end with a negative charge (also called a dipole)

A nonpolar molecule has no charged ends or the same charged ends.

Polarity & Dipoles

Dipoles (polar molecules) - molecules with 2 oppositely charged ends.

Chemists use arrows to represent the polarity of a bond and a molecule.

Polar bonds = polar or nonpolar molecule

Nonpolar bonds = nonpolar molecule